EPICYCLIC GEAR SYSTEM WITH SUPERFINISHED JOURNAL BEARING

BACKGROUND

[0001] The present invention relates to gas turbine engines, and more particularly, to an epicyclic gear system for use in gas turbine engines.

[0002] Epicyclic gear trains are complex mechanisms for reducing or increasing the rotational speed between two rotating shafts or rotors. The compactness of planetary or star system gear trains makes them appealing for use in aircraft engines.

[0003] The forces and torque transferred through an epicyclic gear train place tremendous stresses on the gear train components, making them susceptible to breakage and wear. However, imperfect alignment of the longitudinal axes of an epicyclic gear train's sun gear, star gear, and ring gear with an input shaft is common due to numerous factors including imbalances in rotating hardware, manufacturing imperfections, and transient flexure of shafts and support frames due to aircraft maneuvers. This misalignment necessitates increased amounts of lubrication (i.e. to form an adequate film thickness) between each journal bearing and interfacing star gear than would otherwise be necessary. Additionally, this misalignment increases the amount of wear experienced by the journal bearing and interfacing star gear. Thus, there is a need for an epicyclic gear system that can accommodate misalignment with a lower degree of wear.

SUMMARY

[0004] An epicyclic gear assembly includes a ring gear, a sun gear, at least one star gear enmeshed between the ring gear and sun gear, a carrier and a journal bearing. The carrier is disposed adjacent the rotatable sun gear and star gear. The journal bearing is disposed in the at least one star gear and connected to the carrier. The journal bearing has an outer radial surface with an amorphous surface finish of less than about 5 micro inches (127 micro mm) measured on an R_a scale and the outer surface of the journal bearing interfaces with an inner surface of the star gear.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. **1** is a schematic cross-sectional side view of a gas turbine engine with an epicyclic gear system.

[0006] FIG. **2** is a schematic cross-sectional view of the epicyclic gear system of FIG. **1**.

[0007] FIG. **3** is a diagrammatic view of the entire epicyclic gear system taken along section **3-3** of FIG. **2**.

DETAILED DESCRIPTION

[0008] FIG. **1** is a schematic cross-sectional side view of gas turbine engine **10**. Gas turbine engine **10** includes low pressure unit or pack **12** (which includes low pressure compressor **14** and low pressure turbine **16** connected by low pressure shaft **18**), high pressure unit or pack **20** (which includes high pressure compressor **22** and high pressure turbine **24** connected by high pressure shaft **26**), combustor **28**, nacelle **30**, fan **32**, fan shaft **34**, and epicyclic gear system **36**. Epicycle gear system **36** includes star gear **38**, ring gear **40**, and sun gear **42**. The general construction and operation of gas turbine engines is well-known in the art.

[0009] As shown in FIG. **1**, low pressure unit **12** is coupled to fan shaft **34** via epicyclic gear system **36**. Sun gear **42** is attached to and rotates with low pressure shaft **18**. Sun gear **42** is rotatably mounted on low pressure shaft **18**. Ring gear **40** is connected to fan shaft **34** which turns at the same speed as fan **32**. Star gear **38** is enmeshed between sun gear **42** and ring gear **40** such that star gear **38** rotates when sun gear **42** rotates. Star gear **38** is rotatably mounted on the stationary gear carrier (not shown) by stationary journal bearing (not shown). When low pressure unit **12** rotates, epicyclic gear system **36** causes fan shaft **34** to rotate at a slower rotational velocity than that of low pressure unit **12**, but in the opposite direction.

[0010] In an alternative embodiment to the embodiment shown in FIG. **1**, epicyclic gear system **36** can be configured in a different manner sometimes called a planetary gear system. In this alternative configuration star or "planet" gear **38** is rotatably mounted on the gear carrier by bearings. Star gear **38** meshes with sun gear **42**. Mechanically grounded, internally toothed ring gear **40** circumscribes and meshes with star gear **38**. Input and output shafts extend from sun gear **42** and the gear carrier respectively. During operation, the input shaft rotatably drives sun gear **42**, rotating star gear **38** about its own axis, and because ring gear **40** is mechanically grounded, causes star gear **38** to orbit the sun gear **42** in the manner of a planet. Orbital motion of star gear **38** turns the gear carrier and the output shaft in the same direction as the input shaft.

[0011] The present application describes epicyclic gear system **36** with interfacing star gear **38** and journal bearing (not shown) surfaces configured to reduce operational friction therebetween. In this manner, epicyclic gear system **36** operates with an increased moment capability (effective operation can occur with axes of gears **38**, **40** and **42** misaligned to a greater degree than could otherwise occur with conventional epicyclic gear systems) and reduced bearing temperatures in a boundary regime condition. More particularly, interfacing star gear **38** and the journal bearing surfaces have a composition that achieves a tribological pairing and either star gear **38** or journal bearing is subject to a manufacturing process that achieves a smooth amorphous surface finish. The tribological pairing of star gear **38** and journal bearing surfaces along with the smooth amorphous finish of the surface of either star gear **38** or the journal bearing allows epicyclic gear system **36** to operate with increased moment capability of about 20 percent when compared to conventional epicyclic gear systems. The tribological pairing of star gear **38** and journal bearing surfaces along with the smooth amorphous finish of the surface of either star gear **38** or the journal bearing also reduces bearing temperatures in the boundary regime condition by about 10 to 15 percent. By reducing the temperature in the boundary regime condition, operational wear between star gear **38** and the journal bearing can be reduced, thus increasing the operation life of the epicyclic gear system **36**. By increasing the moment capability of epicyclic gear system **36**, the size and weight of epicyclic gear system **36** can be reduced.

[0012] FIG. **2** is a cross-sectional view of epicyclic gear system **36** taken through only a single star gear **38**. Epicyclic gear system **36**, however, includes multiple star gears arranged circumferentially around the sun gear **42**. In addition to star gear **38**, ring gear **40**, and sun gear **42**, epicyclic gear system **36** includes journal bearing **44**, lubricant manifold **46**, carrier **48**, and end caps **50**. Journal bearing **44** has interface surface **52** and includes axial passage **54** and radial passages **56**. Radial passages **56** fluidly connect to distribution recess **58**. Star gear **38** includes inner surface **60**. Lubricant manifold **46** is connected to feed tube **62**.